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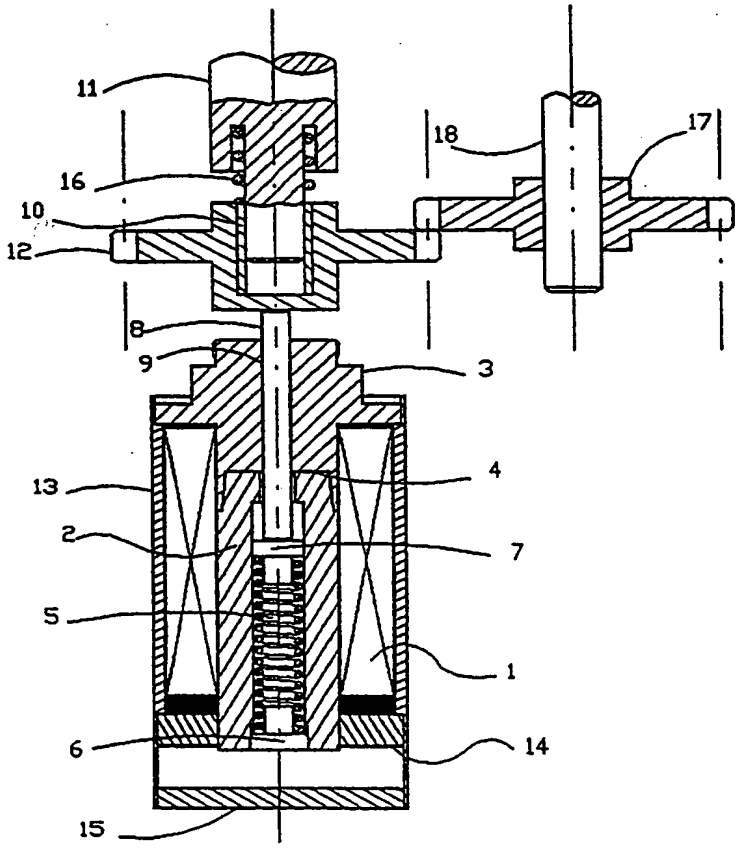
(54) Title: ELECTROMAGNETIC ACTUATOR FOR POWER TAKEOFF OF CHANGE GEAR

(57) Abstract

Electromagnetic actuator particularly for the displacement of gears in power takeoff of change gear, which consists in comprising an electric winding (1) powered through a battery, a fixed armature (3) and a movable core (2) constituting the electromagnet which presents at least an elastic mean (5) for transmitting to the external of the actuator the displacement of said movable core (2) under the action of the magnetic field generated by the winding (1) powered with current.



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**Electromagnetic actuator for power takeoff of change gear**

The present invention relates to an electromagnetic actuator fit for being used in power takeoffs.

Power takeoffs are being used for transferring a part of the power developped by the engine of a vehicle (a farm machine, a lorry, a van) to an operating machine which is driven, carried or is an integrating part of the same vehicle.

Such power takeoffs are substantially constituted by the shaft which transmits power to the operating machine taking it from one of the shafts of the change gear.

The transfer of power is obtained through the coupling of gear wheels (gears or other components having a splined shape) of which one, said driving gear is mounted on a shaft of the change gear whereas the other, said driven gear is carried by the shaft to which it is intended to transfer the power. At rest conditions (non-working) the gear wheels are positioned such that the teeth are not in contact, and consequently the transmission of the movement is not carried out. In working condition the two gear wheels are connected each other directly or through intermediate gears; the connection is obtained through the axial displacement of one of the two wheels or of the intermediate gears. Such displacement is carried out through a manual, pneumatic, electromechanical or electromagnetic actuator. To allow the engagement it is necessary to have the right correspondence between the teeth of one wheel and the spaces of the other. When said correspondence is not obtained, it is necessary to repeat many times the operating manouvres until the wanted result is achieved.

According to the prior art the axial displacement of the gear wheels is obtained through compound lever, manually operated cables and gears transmission, or through pneumatic or electromagnetic actuators.

In power takeoffs having a pneumatic actuator the displacement is obtained through the force carried out by a piston powered by compressed air produced by an air compressor.

If a contact tooth against tooth takes place, the displacement is not carried out. In this case it may be necessary:

1) to repeat the sequence of the operations;

2) to mantain the same pressure in the pneumatic actuator, in order to mantain the contact between the gear wheels, to disengage the clutch so that the driving wheel will be newly moved by the engine, until the wheels are in position of engagement. This

embodiment has the disadvantageous feature that it requires the presence on the vehicle of a compressor, of connecting pipes and of the relative valves which allow the feeding of the actuator, all this is uneasy and expensive due to impediments and weights especially for vehicles of small dimensions which usually are not supplied with them.

In power takoffs having an electromagnetic actuator the axial displacement of the gear wheels is obtained powering the electromagnet with a high intensity current for obtaining a high pickup force, whereas the maintaining in the achieved position is obtained by a lower intensity current. The current comes to the electromagnet from the battery which is installed on the vehicle.

An usually used electromagnet comprises a cylindrical or of an other shape armature, and a movable core which moves axially due to the magnetic field caused by the winding. The movement of the core is transmitted to the driven wheel through actuating means such as a pickup spindle.

For bringing the wheels in working position, the electromagnet is powered with a high intensity current in order to obtain a magnetic field suitable to generate a magnetic attracting force between the movable core and the armature allowing their coupling.

Once the working position is reached, to maintain the movable core in contact with the armature and consequently the gear in working position, it is sufficient to power the electromagnet with a current having a lower intensity than that necessary to obtain the displacement of the same movable core.

Using this kind of actuator, it is however possible to have the contact tooth against tooth between the wheels and consequently it will be not possibile to obtain the immediate engagement. In such a condition the whole manouvre has to be repeated or it is necessary to mantain the high intensity current for a longer time.

This embodiment shows many problems when the engagement does not take place. Problems which arise from the disadvantage of being forced to repeat the manouvre without being certain to achieve a good result and problems arising from the possible damage of the electromagnet. The excessive number of repeated manouvres together with a too long supercharching time cause the extreme heating of the electromagnet with consequent loss of efficiency and risk of damage of the same electromagnet. Furthermore, the manouvre needs a relevant skill and timeliness by the operator to find the synchronism of the gears.

Aim of the present invention is to operate power takeoffs through an electromagnetic actuator which is able to obviate to the disadvantages shown by the actuators

known in the state of the art, and to allow the use of an actuator without risks of bad working caused by the overheating of the electromagnet or by the damage of the feeding winding of the electromagnet and whose use does not require particular skill by the operator. Furthermore, it prevents the loss of time of repeating from the beginning the operations for the engagement of the gears and without using pneumatic actuators, whose use is almost impossible especially for vehicles of small dimensions because they are not supplied with a compressor.

Such embodiment has the pecularity to exercise a relevant force for an unlimited time without causing problems due to the overheating. The permanent applied force allows to operate in the following way, which is different from the other known electromagnets, in case of unsuccessful engagement: to disengage the clutch so that the driving wheel will be moved newly by the vehicle's engine, until the correspondence of the gears and their consequent engagement are achieved thank to the permanent force applied by the electromagnet on a gear wheel. The use of the clutch can be made anytime and repeated many time and for an undetermined period of time until the wanted result is achieved.

This and other aims are achieved by the electromagnetic actuator according to the invention which comprises an electric winding powered through the battery, a fixed armature and a movable core constituting the electromagnet, and it is characterized by the fact that inside the electromagnet at least an elastic component is placed and constrained to means for transmitting to the external of the actuator the displacement of said movable core under the action of the magnetic field generated by the winding powered by current. The electromagnetic actuator according to the invention is further characterized by the fact that said elastic component has a terminal part which is integral with the movable core whereas the other terminal part is suitable to carry out a relative motion according to said movable core. Further feature is the fact that the means fit for transmitting to the external of the actuator the displacement of the movable core are suitable to carry out a relative motion according to the same movable core, being constrained to said elastic component.

Further features and advantages of the invention will more clearly arise from the following preferred but not limitative description, with reference to the attached drawings in which:

- Fig. 1 shows a first embodiment with the drop out electromagnet;
- Fig. 2 shows the same embodiment with the excited electromagnet but in the

condition of contact tooth against tooth;

- Fig. 3 shows the embodiment of Fig. 2 with the gear displaced in power takeoff position.

The electromagnetic actuator according to the invention comprises an electric winding (1) powered with a high intensity current to achieve a relevant force in the pickup manouvre for a limited period of time, and with a low intensity current for the mantaining for an unlimited period of time, a movable core (2) which is able to slide inside the winding (1). The movable core (2) has a terminal part shaped to connect itself to a fixed part (3) of the armature having a counter-shaped surface (4), the range of slide of the movable core (2) is determined by the magnetic field generated by the winding (1) powered with current.

In the preferred embodiment the elastic component inside the electromagnet is a spring (5); said spring has the aim to accumulate as elastic force - in the non-gear engagement between the gear wheels - a part of the work made by the magnetic field for the displacement of the movable core (2), and then releasing such work when the driven wheel (12) and the driving wheel (17) will reach the favorable requested position for the engagement. In the shown embodiment the spring (5) works at compression and it is placed inside the movable core (2), it has a terminal part rested to a closing component (6) and integral with said movable core and the other terminal part is integral with a sliding part (7) inside the same movable core.

The sliding part (7) inside the movable core causes a pushing motion on the spindle of the actuator (8). The displacement of the spindle (8) is no more directly dependent from the displacement of the movable core being the internal terminal part of the actuator constrained to the part (7) which is sliding inside the movable core. The spindle (8) comes out from the armature through a suitable hole (9) present on the same armature and it operates on the gear driven wheel (12) mounted on the shaft (11) through a bush (10).

The component (13) together to the component (3) and the component (14) constitute the armature of the electromagnet. The bottom cap (15) is the resting part for the movable core (2) in the non-working condition.

In the non-working condition (see Fig. 1) the movable core (2) is rested on the bottom cap (15) of the actuator, the spring (5) is in a non-working position. The spindle of the actuator (8) does not operate on the driven wheel (12). In this condition the electric winding (1) of the electromagnet is not powered.

To reach the working position it is necessary to power the electric winding (1) with a current having an intensity such to generate a magnetic field suitable for attracting the movable core (2) towards the fixed part (3) of the armature with a force suitable to compress the spring (5).

Once the contact between the movable core (2) and the fixed part (3) of the armature is obtained, the winding (1) has to be powered with a current having a lower intensity to mantain the movable core (2) attracted to the armature in working position. If a contact tooth against tooth takes place between the driven wheel (12) and the driving wheel (17) mounted on the shaft (18), the driven wheel (12) is prevented in its axial displacement; the same condition involves also the spindle (8) of the actuator.

As the movable core (2) makes however its displacement until it reaches the fixed part (3) of the armature, the spring (5) is compressed. The spring (5) in this way will continue to push on the spindle (8) of the actuator and consequently on the driven wheel (12).

When the gears will reach the position suitable for the engagement, operating the clutch, the engagement will take place thank to the permanent push of the spring (5).

Once the working step is finished, to return to the rest position, the powering of the electric winding (1) of the electromagnet is interrupted, which will be in this way drop out, the movable core (2) can be brought in the starting position as indicated in Fig. 1 for example through suitable means such as spring (16), placed on the shaft of the driven wheel.

The so conceived invention is suitable to variations and changing all belonging to the same inventive concept, furthermore all the details can be substituted with other technically equivalent components.

## CLAIMS

1) Electromagnetic actuator for power takeoff of change gears having an electric winding (1) powered through a battery, a fixed armature and a movable core (2) constituting the electromagnet, characterized by the fact that inside the electromagnet at least an elastic component (5) is present and constrained to means (8) for transmitting to the external of the actuator the displacement of said movable core (2) under the action of the magnetic field generated by the winding (1) powered with current; said elastic component (5) having a terminal part (6) integral with said movable core whereas the other terminal part (7) being suitable of relative motion according to said movable core (2), to said terminal part free of relative motion according to the movable core (2) being constrained said means for transmitting to the external of the electromagnet the displacement of said movable core.

2) Electromagnetic actuator according to claim 1° characterized by the fact that the elastic component inside the electromagnet is constituted by at least one spring (5).

3) Electromagnetic actuator according to claim 1° characterized by the fact that said means for transmitting to the external of the electromagnet the displacement of the movable core are constituted by at least one spindle (8).

4) Electromagnetic actuator according to claim 3° characterized by the fact that said spindle (8) has a terminal part (7) constrained to the terminal part of said spring (5) not integral in motion with said movable core.

5) Electromagnetic actuator according to claim 4° characterized by the fact that the constraint between said spindle (8) and the terminal part of the spring (5) not integral in motion with said movable core is a simple bearing.

6) Electromagnetic actuator according to claim 4° characterized by the fact that the constraint between said spindle (8) and the terminal part of the spring (5) non integral in motion with said movable core is a simple beat.

7) Electromagnetic actuator according to claim 2° characterized by the fact that the terminal part of the spring (5) integral in motion with the movable core is integral constraining the same to a bottom cap (15) connected to the movable core.

8) Electromagnetic actuator according to claim 6° characterized by the fact that the constraint between said terminal part of the spring (5) integral in motion with the movable core and a bottom cap (15) is a simple bearing.

9) Electromagnetic actuator according to claim 2° characterized by the fact

that said terminal part of the spring (5) suitable of relative motion according to the movable core is such from the connection to a guide part inside the movable core and to this connected having a backlash.

10) Electromagnetic actuator according to claim 1° and to any of the previous claims characterized by the fact of working, in a first step, with a feeding current of the electric winding (1) suitable to generate a magnetic field such to determine the displacement of the movable core (2) with a force suitable to change the lenght of the spring (5), and once the displacement of the movable core is reached, to mantain it in the achieved position for a unlimited time with a feeding current sufficient to those aim.

11) Electromagnetic actuator according to claim 1° and to the previous claim characterized by the fact that said changing of lenght of the spring (5) causes that the spring will operate with a consequent force on said spindle (8), causing its displacement, transmitting in such a way to the external of the actuator the displacement of the movable core, said movement is in this way transmitted to the gears of the power takeoff.

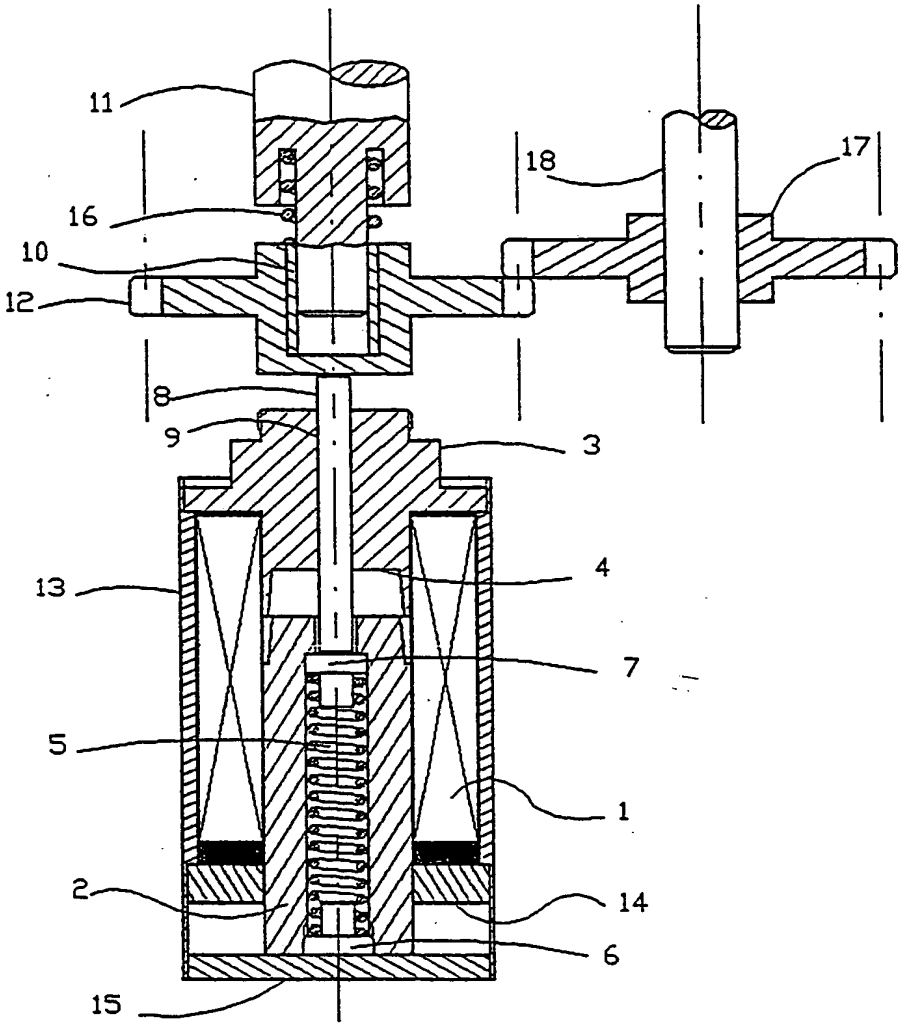


*Fig. 1*

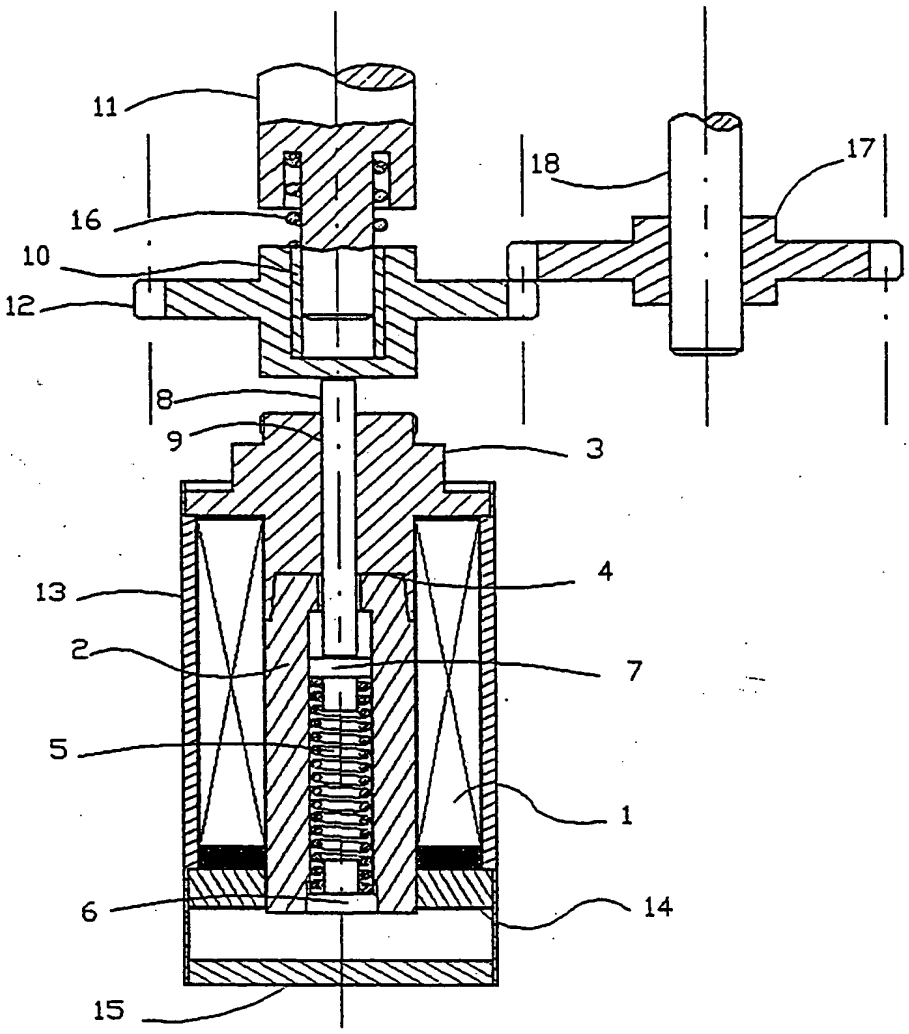


*Fig. 2*

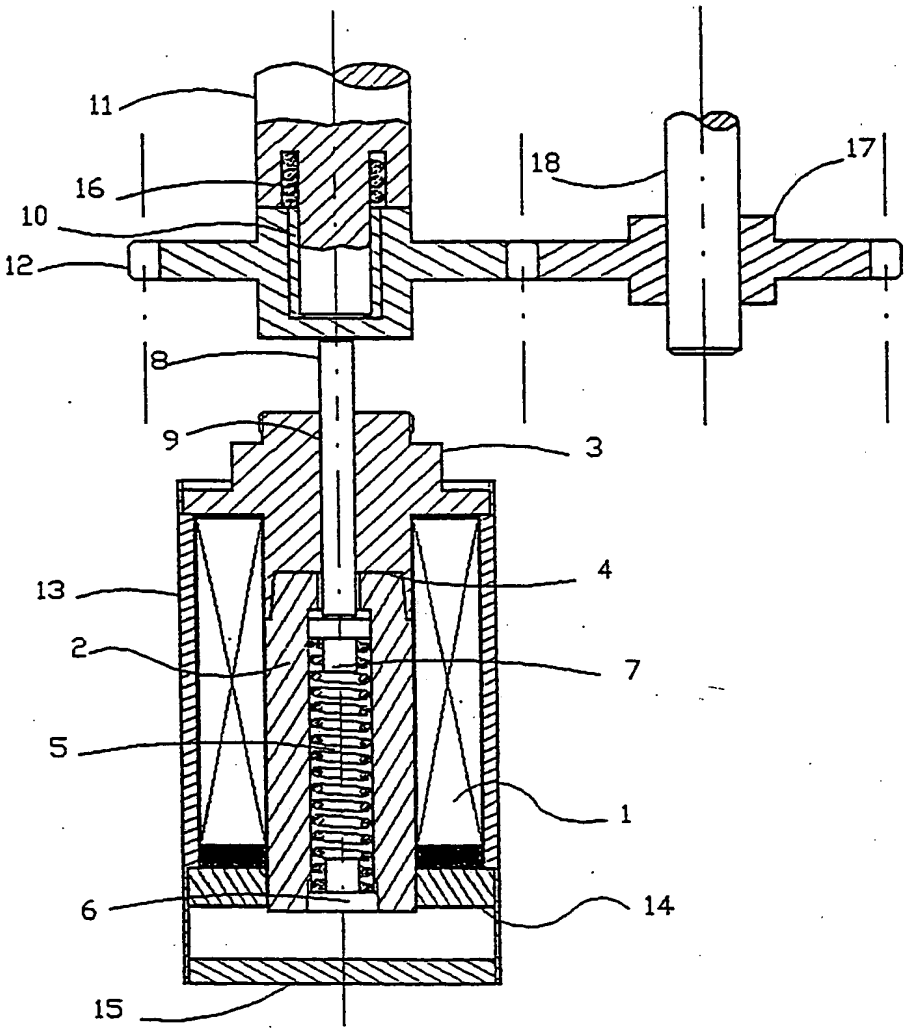


*Fig. 3*

# INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
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| A | see column 4, line 28 - line 73; figures | 4,5,7,10 |
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